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Pulsar's "Fire Hose" Jet May Boost Understanding of Black Holes

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By SPACE.com Staff, SPACE.com

A tendril of particles whipping around a pulsar at half the speed of light could help scientists gain a better understanding of the energetic jets spewing from pulsars and black holes.

Researchers using NASA (news - web sites)'s Chandra X-ray Observatory to study the Vela pulsar, a rotating neutron star in the Southern Hemisphere constellation Vela (the Sails), caught a series of images showing a jet writhing out from the main star at phenomenal speed. An animation of the images has been compiled to show the pulsar in action and can be found at the Chandra website.

"The most striking thing about this jet is how rapidly it changes both its shape and brightness," said George Pavlov, a senior scientist at Pennsylvania State University, in a written statement. "Such strong, fast variability has never been observed in astrophysical jets." Pavlov is the lead author of the Vela study, which will appear in the July 10th issue of the *Astrophysical Journal*.

Pavlov used the Chandra X-ray Observatory to image the Vela jet 13 times between January and August of 2002. While the jet displayed a remarkable rate of change over just eight months, its behavior could be indicative of similar jets emanating from larger objects like supermassive black holes, which could have periods ranging over millions of years, researchers said.

The Vela jet roughly a half light-year long and made up of extremely high-energy electrons or their antimatter counterparts, called positrons, that spin around a magnetic field. The particles are produced by voltages 100 million

times that of a lightning bolt and are confined to a somewhat constant width, despite the jet's snake-like movement. One light-year is about six trillion miles (9.7 trillion kilometers) long.

Researchers said the jet's steady width could be due to a magnetic field produced by electrons along its axis. The jet's ability to change rapidly could be produced by a phenomena called "fire hose instability" that has been observed in laboratory jet studies.

"Imagine a firehouse lying on the ground," said Marcus Teter, the study's co-author. "After you turn on the water, you will see different parts of the hose kinking up, and moving rapidly in different directions, pushed by increased pressure at the bends in the hose. The Vela jet resembles a hose of magnetic fields, which confines the electrically-charged particles."

The instability could be triggered by a strong headwind created as the pulsar moves through surrounding gas at 200,000 miles (300,000 kilometers) an hour, scientists said. Bright blobs inside the jet could be a sign of the increased magnetic field and particle pressure along the kinks in the jet, they added.

According to the study, the jet's speed and brightness along its outer regions also suggests that the luminescent bands encircling the Vela pulsar may not be rings of material as previously thought, but shockwaves caused as the jet passed through clouds of material along its path.

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